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FINAL REPORT

FOOD UTILIZATION OF HEMPSEED FLOUR: CHEMICAL AND MICROBIAL ANALYSIS AND FOOD PROTOTYPE DEVELOPMENT

19990076

Funded by
The Agriculture Development Fund

March 2001
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Food Utilization of Hempseed Flour: Chemical and Microbial Analysis and Food Prototype Development ADF 9900006

Monthly Report
December 1-31, 1999

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Summary

Hemp flour was analyzed for THC content; the concentration of THC was below the detection limit of the methodology employed. Compared with whole oat flour (unstabilized) and whole wheat flour, the hemp flour had the longest shelf life at 70°C and the highest antioxidant activity. Two types of food products, bread and bagels, were prepared using hemp flour mixed in various proportions with whole wheat flour. Hemp bread required more water in the formula than anticipated from the water absorption of hemp flour. Loaf volumes, loaf heights, and crumb colour decreased and loaf weight increased, with an increase in the proportion of hemp flour in the formula. Crumb scores for hemp breads were similar to that of whole wheat bread. An undesirable flavour was detected in bread when the content of hemp flour was above 15%. Hemp bagels were darker in colour than were whole wheat bagels. Bagel height decreased, and bagel density and weight loss increased, with an increase in the proportion of hemp flour in the formula. An undesirable flavour was detected in bagels when the content of hemp flour was above 10%.

Materials and Methods

A. Materials

Industrially pin-milled hemp flour

Commercial whole wheat flour (obtained from a local food store)

Unstabilized whole oat flour (prepared from undehulled oat using a coffee grinder)

B. Analytical Methods

1. Tetrahydrocannabinol (THC) concentration: determined by Maxxam Analytics, Inc.

2. Rancidity: of hempseed flour, whole wheat flour, and oat flour was determined by AOCS method Cg 5-97.

3. Antioxidant activity: measured by determining the absorbance of the $ABTS^{+}$ radical cation at 120 min according to Miller et al., 1993.

4. Color: of bagel and bread crumb was determined with a HunterLab MiniScan (Hunter Associates Laboratory, Inc., Reston, VA).

C. Food Formulation Trials

Bread

a. Formula:

	Flour Basis (%)
Whole wheat flour, 14% moisture basis	80.0--100.0
Hemp flour, 14% moisture	20.0--0.0
Yeast, compressed	2.0
Sugar	6.0
Salt	1.5
Shortening	3.0
Malt	0.2
Whey	4.0
No fat dry milk powder	2.0
Gluten	3.0
SSL	0.5
Ammonium phosphate	0.1
Water	71.0
Ascorbic acid	50ppm

b. Method: American Association of Cereal Chemists (AACC) Method10-10B: Optimized Straight-dough Bread-making Method (modified as follows).

	Fermentation	First punching	Second punching	Panning	Proof time
AACC	180 min	105min	50 min	25min	60min
Modified	155min	105min	50min*	--	75min

* Second punching and panning at the same time.

Bagels

a. Formula :

Whole wheat flour	70--100.0 g
Hemp flour	0.0--30g
Gluten	3.0 g
Sugar	3.0 g
Salt	2.0 g
Yeast	1.2 g
Water	76.0 ml

b. Method:

1) Mix flour and gluten well in a plastic bag. Add water, yeast and sugar to the Muzeen & Blythe mixer bowl; mix for 2 minutes; add the dry ingredients to the mixer bowl and mi v dough to rest for 1.5 minutes.

allow yeast to hydrate for 2min @ 1PR occasionally

2) Roll dough by hand until dough roll is 19 cm in length. Press ends toget Roll dough using sheeter ↑ 20cm wet one end in H_2O and press together to form circle or lightly oiled a formed ... silicon ... sheets, ... covered ... ners.

3) P ... or lightly oiled

4) I ... itor ...

min...

5) Boil bagel in rapidly boiling water for 2 minutes; turn bagel over and boil for 2 minutes.

6) Remove and place bagel on rack to drain for 30 seconds.

7) Bake at 232 °F for 15 minutes.

8) Remove from baking sheet and cool at room temp for 1 hour. 9) Store in 2 ziplock bags.

Results

1. Tetrahydrocan

Tetrahydrocar ... narijuana. Food grade hemp products should contain only negligible amounts of ... (< 10 umoles). Hempseed flour was tested for THC concentration and the content of THC was too low to be detected.

2. Rancidity

Lipid oxidation leading to rancidity is often the ultimate determinant of the useful storage life of food products. Oxidation of unsaturated lipids not only produces offensive odours and flavours, but can also decrease nutritional quality and safety by the formation of secondary reaction products in foods after cooking and processing (Frankel, 1980). Results of oven storage tests of hemp flour, unstabilized whole oat flour, and whole wheat flour are

shown in Table 1. Hemp flour (with the highest fat content at ~9%) had the longest shelf life at 70°C, whereas the unstabilized whole oat flour had the shortest shelf life.

Table 1. Oven storage test of hemp flour, unstabilized oat flour, and whole wheat flour.

Flour	Storage period at 70°C (days)	Sensory score*
Hemp	9	no
Unstabilized oat	3	++
Whole wheat	9	+

* no: no offensive odor; + : started lightly offensive odor; ++ : strongly offensive odor.

3. Antioxidant activity

The intake of antioxidant compounds present in food is an important health-protecting factor. Mediterranean diets rich in natural antioxidants are associated with a reduced incidence of cardio- and cerebrovascular diseases (Hertog et al., 1993). Antioxidants extend the shelf life of fat-containing foods. Table 2 shows antioxidant activities of hemp flour, unstabilized whole oat flour, and whole wheat flour. Antioxidant activity is expressed as " Trolox equivalent antioxidant capacity (TEAC)" in μg/g of flour (Miler et al., 1993; Vincenzo et al, 1999). Hemp flour had the highest antioxidant activity, and unstabilized whole oat flour, the lowest.

Table 2. Antioxidant activity of hemp flour, unstabilized whole oat flour, and whole wheat flour

Flour	TEAC value
Hemp	2.64±0.02
Unstabilized whole oat	0.38±0.02
Whole wheat	0.81±0.03

4. Hemp bread

The mix time and water absorption for hemp bread (at 5% substitution of hemp flour. for whole wheat flour) were similar to corresponding value for whole wheat bread. Mix time and water absorption decreased with an increase in the proportion of hemp flour in the mixture when the proportion of hemp flour was above 10%; the quality of hemp bread was poor if the amount of water in the formula was in accordance with the water absorption of hemp flour. Consequently, the same amount of water and the same mixing time was used for hemp bread and whole wheat bread. The crumb scores of hemp bread were similar to that of whole wheat bread, but the loaf volume, loaf height, and crumb color of hemp bread decreased, and loaf weight increased, with an increase in the proportion of hemp flour in the formula (Table 3). There was virtually no difference in flavour between hemp bread and whole wheat bread when the proportion of hemp flour was 5%. However, an undesirable flavour was detected when the content of hemp flour was 10% or higher.

Table 3. Quality of hemp breads and whole wheat bread

Bread formulation	Mix time (min)	Loaf volume (cc)	Loaf height (cm)	Loaf weight (g)	Crumb score *	Crumb color (L)
Whole wheat	14.5	775	10.7	160.8	7.0	58.4
5% Hemp	14.5	755	10.3	161.9	7.0	48.6
10% Hemp	14.5	725	9.9	161.3	7.0	41.9
15% Hemp	14.5	690	9.4	162.9	7.0	39.7
20% Hemp	14.5	625	9.1	163.4	6.5	36.5

* Maximum score is 10 according to cell uniformity:

10: very even and uniform
8: slightly uneven
6: moderately uneven
4: very uneven
2: extremely uneven
0: unacceptable

5. Hemp bagels

The crumb colour of hemp bagels was darker than that of whole wheat bagels. The height of hemp bagels decreased, and weight loss and density increased, with an increase in the proportion of hemp flour in the formula (Table 4). In addition, an undesirable flavour was detected when the proportion of hemp flour in the formula was 10% or higher.

Table 4. Quality of hemp bagels and whole wheat bagels

Bagel formulation	Height (cm)	Weight loss (%)	Brightness (L)
Whole wheat	6.2	14.4	53.5
5% Hemp	6.2	14.6	46.5
10% Hemp	5.9	14.8	
15% Hemp	5.9	14.8	
20% Hemp	5.8	14.7	
25% Hemp	5.6	15.0	
30% Hemp	5.3	15.7	2

Personnel

Ms. Sherry Xie, Technical Research Assistant and Graduate Student
Gerald Henrikson, Technical Research Assistant
Dr. R. T. Tyler, Director and Head

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Summary

Two hemp flour samples, one grounded in an industrial pin mill, the another in a lab pin mill, were analyzed for moisture, crude protein, crude fat and ash content. The results showed that the industrially pin-milled flour was lower in moisture than the lab pin-milled flour, otherwise, the two samples had similar contents of protein, fat, and ash. The industrially milled flour had higher total aerobic bacteria and yeast and mold counts than did whole wheat flour. Three types of food products, pasta, cookies, and muffins, were prepared using industrially pin-milled hemp flour mixed in various proportions with semolina or whole wheat flour. The cooking time required for hemp pasta was shorter than that required for semolina pasta, but cooking loss was higher for hemp pasta. The hardness of hemp pasta increased, and the springiness decreased, with an increase in hemp flour content. Hemp pasta was darker in color than semolina pasta. Hemp cookies had a peanut-like flavour when the hemp flour content was less than 25%. Hemp muffins became more dense at higher hemp flour concentrations. There was almost no difference between hemp muffin and whole wheat muffin in tasting flavour if the proportion of hemp flour was less than 20%.

Analysis

Materials

1. Industrial pin-milled hemp flour: the hempseed cake was ground in an industrial pin mill (InfraReady Products Ltd., Saskatoon).
2. Lab pin-milled hemp flour: the hempseed cake was ground twice in a lab- scale pin mill (Alpine, Type 63C).
3. Commercial whole wheat flour: obtained from a local food store.
4. Quick rolled oats: obtained from a local food store.
5. Semolina flour: obtained from a local store.
6. Whole wheat flour: obtained from a local food store.

Analytical Methods

1. Proximate analysis: concentrations of moisture, nitrogen, ash, and lipid were determined by AACC (American Association of Cereal Chemists) methods. A nitrogen factor of 6.25 to protein conversion was used to calculate crude protein concentration.

2. Microorganisms: total aerobic bacteria were determined on standard plate count agar (Difco, Lab), yeasts and molds were determined on potato dextrose agar (Difco, Lab).
3. Color determination: cookie and pasta colour were determined with a HunterLab MiniScan (Hunter Associates Laboratory, Inc. Reston, VA), using the Hunter Lab color scale where "L"

indicates brightness, "a" red - green and "b" yellow - blue.

4. Hardness and springiness: cooked pasta hardness and springiness were measured with a texture analyzer (Food Technology Corporation, Rockville, Maryland, model TMS-90).

Food Formulation Trials

1. Pasta
   a. Materials: industrially pin-milled hemp flour at four levels (5, 10, 15, and 20%) was mixed with semolina and used for pasta making.
   Extruder: Model: Pasta Mak'rv, Bonneot Co. Specifications: screw die, 58mm diameter; die openings, length 8.5mm, width 1.5mm.
   b. Methods: 1kg mixed flour place into a mixing bowl, add ~285ml water and mix for 5min, rest for 20min, then place the mixture into an extruder to extrude pasta.
   Pasta cooking quality was determined by AACC method 16-50.

2. Cookies
   a. Materials: Industrially pin-milled hamp flour (5, 10, 15, 20, 25 and 30%)was mixed with whole wheat flour
   Ingredients:

Flour	160g	Salt	2.4g
Baking soda	2.8g	Egg	50g
Shortening	90g	Milk(2% fat)	15g
Sugar	104g	Brown sugar	100g
Vonilla extract	3g	Quick rolled oats	110g

vegetable → Vanilla

our, quick rolled oats, baking soda, baking powder, and salt were mixed well
.c bag. Brown sugar, white sugar, shortening, egg, vanilla, and milk were
a bowl for 30s, the dry ingredients were added to the mixing bowl and
nixed for 30s. The bowl was scraped and the contents mixed for an additional 30s. Dough was rolled out and cut on a cutting board. Cookies were baked for 10 min at 350°F. The diameter and height of the cookies were measured using a ruler.

3. M Cookies placed on pans ~~spoon~~ teaspoon size) spread) 29.5 and 42.7mm

↑ cookie dough

y pin was rolled out on mix waxed paper. Top and bottom. Height was measured between metal guides 4mm thick

ls (Cookies were cut using 2 sizes cookie cutter

egg 50

ulated sugar 20g

Baking powder	9g
Salt	2g

remove cookies from oven cool 5min. remove from pan & cool on wire racks for 25min. Store in Ziplock Bags.

b. Method: Flour, baking powder, sugar, and salt were sifted into a plastic bag and mixed well. Milk , oil, egg, and molasses were placed in a small bowl and whisked, the dry ingredients were added to the bowl, and the mixture stirred only until dry ingredients were moistened. Sixty gram portions of batter were weighted into muffin molds, and the muffins baked for 15 min at 375° F. The diameter and height of muffins were measured using a ruler.

Results

1. Composition

The moisture of the industrially [illegible] flour was lower than the lab milled sample, but the crude fat, crude protein, and ash contents were similar.

Table 1. Proximate composition of hempseed flour (% as is moisture basis)

Composition	Industrial pin-milled hempseed flour	Lab pin-milled hempseed flour
Moisture	4.4	6.0
Crude fat	9.7	9.6
Crude protein	29.2	28.9
Ash	6.6	6.4

2. Microbiological analysis

Results from microbiological analysis of hempseed flour and whole wheat flour are shown in Table 2. Total aerobic bacteria and yeasts and moulds for hempseed flour were higher than for whole wheat flour obtained from a local food store. According to industrial experience in the United States, flour(s), cornmeal, corn grits, and semolina have a normal level of 10^2-10^6 per gram of total aerobic bacteria and 10^2-10^4 of yeasts and moulds per gram (Sillier et al. 1980). For flour and corn meal, 12% water is a critical level, at or below which there will be no microbial growth, and the flour is completely stable. At 15%, moulds can grow; and at 17%, moulds, yeasts, and bacteria can grow (Frazier, 1967; Hesseltine and Graves, 1966). If industrially pin-milled hempseed flour is maintained at a low moisture, it will not support the growth of microorganisms.

Table 2. Analysis of microbial counts in hempseed flour and cereal flours.

Sample	Total aerobic count (CFU/g)	Yeast & mold (CFU/g)
Industrial pin-milled hempseed flour	7.8×10^3	3.4×10^3
Whole wheat flour	1.0×10^2	5.0×10^1

3. Cooking quality of hemp pasta

Cooking time decreased from 16.5 min to 13.5 min as the level of hempseed flour added to semolina was increased from 5 to 20%; cooking loss increased from 6.3 to 9% over this range (Table 3). Cooking times for all the hemp pastas were shorter than that of semolina pasta, cooking loss was higher than that of semolina pasta. Hardness of cooked hemp pasta increased from 11.31 to 140.1 lbs as the level of hempseed flour was increased from 0 to 20%, but springiness decreased from 0.04 to 0.02 in over this range. Semolina pasta was brighter in colour than pasta made from hemp flour and semolina. There was a sandy feeling in the mouth as the hempseed flour content was increased past 10%, because bran particles from hempseed flour in the pasta were still hard after cooking. The tasting quality of hemp pasta would be improved if the bran is removed from hempseed flour by sieving prior to pasta making.

Tabie 3. Hemp pasta cooking quality

Sample	Cooking time (min)	Cooking loss (%)	Hardness (lbs)	Springiness (in)	Brightness (L)
Semolina	17.5	6.0	113.1	0.04	52.6
5% hemp flour	15.5	6.3	112.5	0.04	38.4
10% hemp flour	15.5	7.4	120.4	0.03	34.2
15% hemp flour	15.0	8.3	133.0	0.03	31.4
20% hemp flour	13.5	9.0	140.1	0.02	26.8
LSD(p<0.05)	2.7	2.2	11.0	0.02	17.3

4. Hemp cookies

The diameters, heights, and weight losses of hemp cookies were similar to those made from 100% whole wheat flour, but the colour of hemp cookies was darker than whole wheat cookies (Table 4). Hemp cookies had a peanut-like flovour at hemp flour contents less than 25%. An undesirable flavour was present at hemp flour contents above 25%.

Table 4. Diameter, height, weight loss, and color of hemp cookies

Cookies	Diameter (cm)	Height (cm)	Weight loss (%)*	Brightness (L)
Whole wheat flour	8.1	1.1	7.1	56.9
5% hemp flour	8.2	1.1	7.2	52.0
10% hemp flour	8.1	1.1	7.0	47.1
15% hemp flour	8.1	1.2	7.0	44.3
20% hemp flour	8.0	1.1	7.2	41.1
25% hemp flour	8.1	1.1	7.2	41.1
30% hemp flour	8.1	1.1	7.0	39.8
LSD($p<0.05$)	0.1	0.1	0.2	11.2

* weight loss (%) = (cooked weight/ wet weight) × 100%

5. Hemp muffins

The diameters of hemp muffins were similar to that of whole wheat muffins,, but their heights decreased and weight loss increased with increasing hempseed flour content (Table 5). There was virtually no difference in flavor between hemp muffins and whole wheat muffin when the hempseed flour content was less than 20%. An undesirable flavour was present in the mouth when the content of hempseed flour above 20%.

Table 5. Diameter, height and weight loss of hemp muffin

Muffin	Diameter(cm)	Height(cm)	Weight loss (%)*
Whole wheat flour	6.9	4.5	9.3
5% hemp in whole wheat flour	6.9	4.4	9.5
10% hemp in whole wheat flour	6.9	4.4	9.4
15% hemp in whole wheat flour	6.9	4.4	9.7
20% hemp in whole wheat flour	6.9	4.4	9.4
25% hemp in whole wheat flour	6.8	4.1	9.6
30% hemp in whole wheat flour	6.8	4.1	9.6

* weight loss(%)= (cooked weight/wet weight)× 100%

Work plan for December 1999

1. THC and rancidity analysis.
2. Products of bread and bagels with industrially pin-milled hempseed flour / whole wheat Bread.

Personnel

1. Ms. Sherry Xie, Technical Research Assistant and Graduate student
2. Gerald Henriksen, Technical Research Assistant
3. Dr. R.T. Tyler, Director and Head

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PROGRESS REPORT (October 1-31, 1999)

SUMMARY

A hempseed flour prepared by grounding the cold-pressed wholemeal in a modified hammer mill followed by sieving through a 36-mesh screen was compared to a hempseed flour sample prepared by grounding the wholemeal in a laboratory-scale pin-mill without further sieving treatment. Although pin-milling had higher extraction rate (100% wholemeal) than the hammer mill (approximately 75%), flour produced by pin-milling was finer therefore whiter in color than hammer-milled sample. A pin-milled flour sample produced by InfraReady Inc. was finer and whiter than the sample prepared in a lab-scale pin mill.

In addition to its rich fiber, protein, lipid and mineral contents, the hempseed flour also contained more essential amino acids than hard red spring wheat. Compared to soy bean, which is the most widely used food protein source, the hempseed flour contained more methionine and valine but less lysine.

ANALYSIS

Materials

1. Hempseed cake: obtained after cold press extraction of hempseed oil.
2. Hempseed flour: the hempseed cake was milled in a modified hammer-mill and sieved via a 36-mesh screen.

Methods and analysis

1. Pin milling in lab: a lab scale pin mill (Alpine, Type 63C) was employed to grind wholemeal of the hempseed cake which was pre-ground in UDY cyclone mill fitted with a 0.5-mm screen. Pin-milling was performed twice consecutively.
2. Industrial pin milling: the hempseed cake was ground in InfraReady Inc., Saskatoon.
3. Determination of particle size distribution: 100 g flour sample, prepared by hammer mill and sieving, or pin-milling in the lab, or pin-milling by InfraReady, was sieved through 40. 50, 60, 70, 80 and 100-mesh screens on a Rotap shaker until constant weights were obtained.
4. Color determination: flour color was determined in HunterLab MiniScan (Hunter Associates Laboratory, Inc., Reston, VA), using the Hunter Lab color scale where 'L' indicates whiteness (brightness), 'a' red to green and 'b' yellow to blue.
5. Determination of protein and amino acid concentration: crude protein was determined according to the standard method (AACC 1995). Amino acids were analyzed by HPLC after acid hydrolysis (Sosulski and Imafidon, 1990. J. Agric. Food Chem. 38: 1351-1356).

Results

1. The effect of milling method on particle size distribution and flour color.

Table 1 and 2 showed flour color (brightness, L-value) and particle size distribution of samples prepared either by hammer mill and sieving, or pin milling in the lab or industrial scale. More than 1/3 of the flour sample prepared by hammer mill followed by sieving through a 36-mesh screen were larger than 40 mesh which was very course and dark (black-looking) in color, not suitable for food applications. In comparison, pin-milling effectively reduced particle size of hempseed cake, showing significant improvement in color. Compared to the lab sample, the industrial ground sample was finer and whiter, indicating pin-mill was more efficient in the industrial scale than the lab scale. Because of the fineness, the industrial pin-milled sample appeared 'stickier' on sieving than the lab sample.

Table 1. Brightness (L-value) and particle size distribution (%) of hempseed flour after different milling treatments.

Analysis	R&D Hemp flour sample	Wholemeal ground in lab pin-mill	Wholemeal ground by InfraReady
Flour color (L-value)	35.6	46.2	53.9
Particle size (mesh)			
>40	33.9	7.4	-
40-50	22.4	66.5	81.3
50-60	24.5	21.1	11.0
60-70	11.3	0.7	1.3
70-80	7.1	3.2	4.9
80-100	0.1	0.2	0.4
<100	0.7	0.9	1.1

Table 2. Brightness (L-value) of hempseed flour samples after sieving

Particle size (mesh)	Sample			*LSD (p 0.001)*
	R&D Hemp	Pin-milled in lab	InfraReady	
>40	25.5	37.1	-	*0.6*
40-50	25.8	46.9	53.1	*0.5*
50-60	37.6	48.4	53.3	*0.5*
60-70	43.5	-	-	-
70-80	44.7	87.3	-	*0.3*
LSD (p<0.001)	*0.3*	*0.3*	*0.2*	

2. Amino acid composition of hempseed flour in comparison with wheat and soy bean

As shown in Table 3, the hempseed flour from wholemeal of hempseed cake was 32% higher in essential amino acids compared to hard red spring wheat and 3% higher than soy bean Compared to soy bean, the hempseed flour contained more methionine and valine but less lysine On flour weight basis, every 100 g of hempseed flour may contain 32 g protein with 12.4 g essential amino acids. In comparison, 100 g of hard red spring wheat contains only 13-15% protein with 4.4 g of essential amino acids (15% protein). On the other hand. soy bean contains more essential amino acids because of its higher protein content than the hempseed flour. This result indicates that the hempseed flour is also a good protein source.

Table 3. Amino acid composition (% total amino acid) of hempseed flour in comparison with wheat and soy bean.

Amino acid	Hempseed flour	Wheat (HRS)[a]	Soy bean[b]
Essential amino acid (EAA) for human nutrition			
Histidine	2.8 (0.9[c])	2.0 (0.3)	2.3 (0.9)
Leucine	7.0 (2.3)	6.6 (1.0)	7.8 (3.0)
Iso-leucine	4.4 (1.4)	4.2 (0.6)	4.9 (1.9)
Lysine	3.9 (1.3)	2.8 (0.4)	6.7 (2.6)
Methionine	2.3 (0.7)	1.3 (0.2)	1.5 (0.6)
Phenylalanine	5.8 (1.9)	4.8 (0.7)	5.1 (2.0)
Threonine	3.8 (1.2)	2.9 (0.4)	3.9 (1.5)
Valine	8.3 (2.7)	4.5 (0.7)	5.1 (2.0)
Total EAA	*38.4 (12.4)*	*29.0 (4.4)*	*37.3 (14.4)*
Sparing amino acids			
½ Cystine	2.1 (0.7)	2.2 (0.3)	1.2 (0.5)
Tyrosine	2.6 (0.8)	3.6 (0.5)	3.6 (1.4)
Non-essential for human nutrition			
Alanine	4.7 (1.5)	3.4 (0.5)	4.5 (1.7)
Arginine	11.9 (3.8)	4.7 (0.7)	7.8 (3.0)
Aspartic acid	11.1 (3.6)	5.4 (0.8)	12.1 (4.7)
Glutamic acid	17.8 (5.7)	30.8 (4.6)	19.2 (7.4)
Glycine	4.6 (1.5)	6.0 (0.9)	4.4 (1.7)
Proline	4.7 (1.5)	10.2 (1.5)	5.3 (2.0)
Serine	5.2 (1.7)	4.5 (0.7)	4.7 (1.8)
Total	100 (32.2)	100 (15.0)	100 (38.6)

[a] Simmonds, D.H. 1978. In: *Cereals '78: Better Nutrition for the world's millions* edited by Pommeranz, Y. American Association of Cereal Chemists, Inc., St. Paul, MN.

[b] Sosulaki, W.F. 1977. Concentrated seed proteins. In: *Food Colloids* edited by Graham H.D. The AVI Publishing Company, Inc., Westport, CN.

[c] numbers shown in brackets indicate g amino acids in 100 g of flour sample.

PLANNED ACTIVITIES FOR NOVEMBER 1999

1. Proximate analysis (moisture, protein, lipids and ash) of the pin-milled hempseed flour samples.
2. Food formulation trials with pin-milled and hammer-milled/sieved flour samples: pasta and cookies.

PERSONNEL

3. Ms. Sherry Xie, Technical Research Assistant.
4. Dr. G. H. Zheng, Principle investigator.

PROGRESS REPORT (September 1-30, 1999)

SUMMARY

Two hemp seed samples, hempseed cake and hempseed flour, were analyzed for moisture, crude protein, crude lipids, ash, soluble and insoluble fiber, and mineral (potassium, phosphorus, sulfur, calcium, magnesium, copper, manganese, iron, zinc and boron) concentration. The hempseed cake sample had higher concentration of crude protein, crude lipids and ash than the hempseed flour sample. Both samples showed similar soluble and insoluble dietary fiber concentration. Compared to wheat bran, the hempseed samples was low in potassium and magnesium, but high in protein, lipid, fibre, calcium, iron and zinc.

ANALYSIS

Materials

1. Hempseed cake: obtained after cold press extraction of hempseed oil.
2. Hempseed flour: the hempseed cake was milled in a modified hammer-mill and sieved via a 36-mesh screen.

Analytical methods

1. Moisture, nitrogen, ash, crude lipid, soluble and insoluble dietary fibre concentration was determined according to the AACC (American Association of Cereal Chemists) standard methods. A 6.25 x nitrogen factor was used to calculate crude protein concentration.
2. Mineral concentration in the ash was determined in an inductively coupled plasma emission spectrometer.

Results

1. Proximate composition (% as-is)

Composition	Hempseed cake	Hempseed flour	Wheat bran[a]
Moisture	8.8	7.4	10-12
Crude protein	32.2	29.8	15
Crude lipid	9.9	9.1	5.4
Ash	6.3	6.0	5
Soluble dietary fibre	0.9	0.8	-
Insoluble dietary fibre	44.8	41.2	12.8

[a] From 'Nutrition: Food and the environment' by Vincent Hegarty, 1995. Eagan Press.

2. Minerals

Sample	Minerals (on as-is basis)									
	P (%)	K (%)	S (%)	Ca (%)	Mg (%)	Cu (µg/g)	Fe (µg/g)	Mn (µg/g)	Zn (µg/g)	B (µg/g)
Hempseed cake	1.4	0.94	0.36	0.15	0.57	19	172	113	88	16
Hempseed flour	1.2	0.83	0.32	0.14	0.51	18	156	107	78	15
Wheat bran[a]	1.0	1.18	-	0.07	0.61	18	105	-	73	-

[a] From Appendix A 'Nutrition: Food and the environment' by Vincent Hegarty, 1995. Eagan Press, St. Paul, MN.

PLANNED ACTIVITIES FOR OCTOBER 1999

1. Analysis of amino acid composition of hemseed cake and flour samples.
2. Analysis of THC in the hempseed cake and flour samples.
3. Milling and refinement of hemseed cake samples.

PERSONNEL

1. Ms. Sherry Xie, Technical Research Assistant.
2. Dr. G. H. Zheng, Principle investigator.